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Tropic Reservoir, Garfield County, Utah

National Eutrophication Survey, Corvallis, Oreg

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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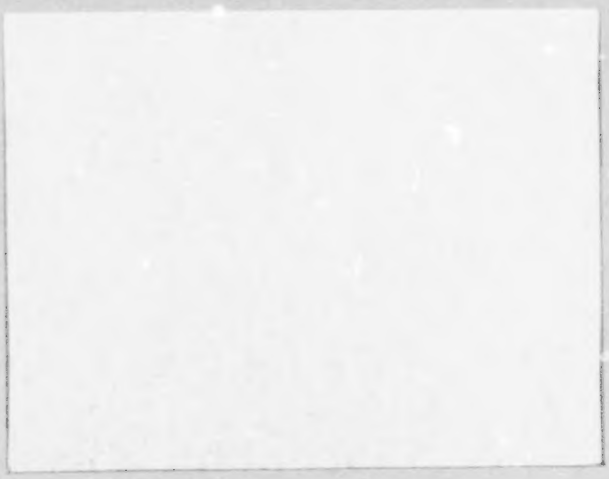

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REPORT
ON
TROPIC RESERVOIR
GARFIELD COUNTY
UTAH
EPA REGION VIII
WORKING PAPER No. 860

WITH THE COOPERATION OF THE
UTAH STATE DIVISION OF HEALTH
AND THE
UTAH NATIONAL GUARD
NOVEMBER, 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Utah Department of Social Services and the Utah Department of Natural Resources for professional involvement, to the Utah National Guard for conducting the tributary sampling phase of the Survey, and to those Utah wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staffs of the Bureau of Water Quality of the Division of Health and the Division of Wildlife Resources provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

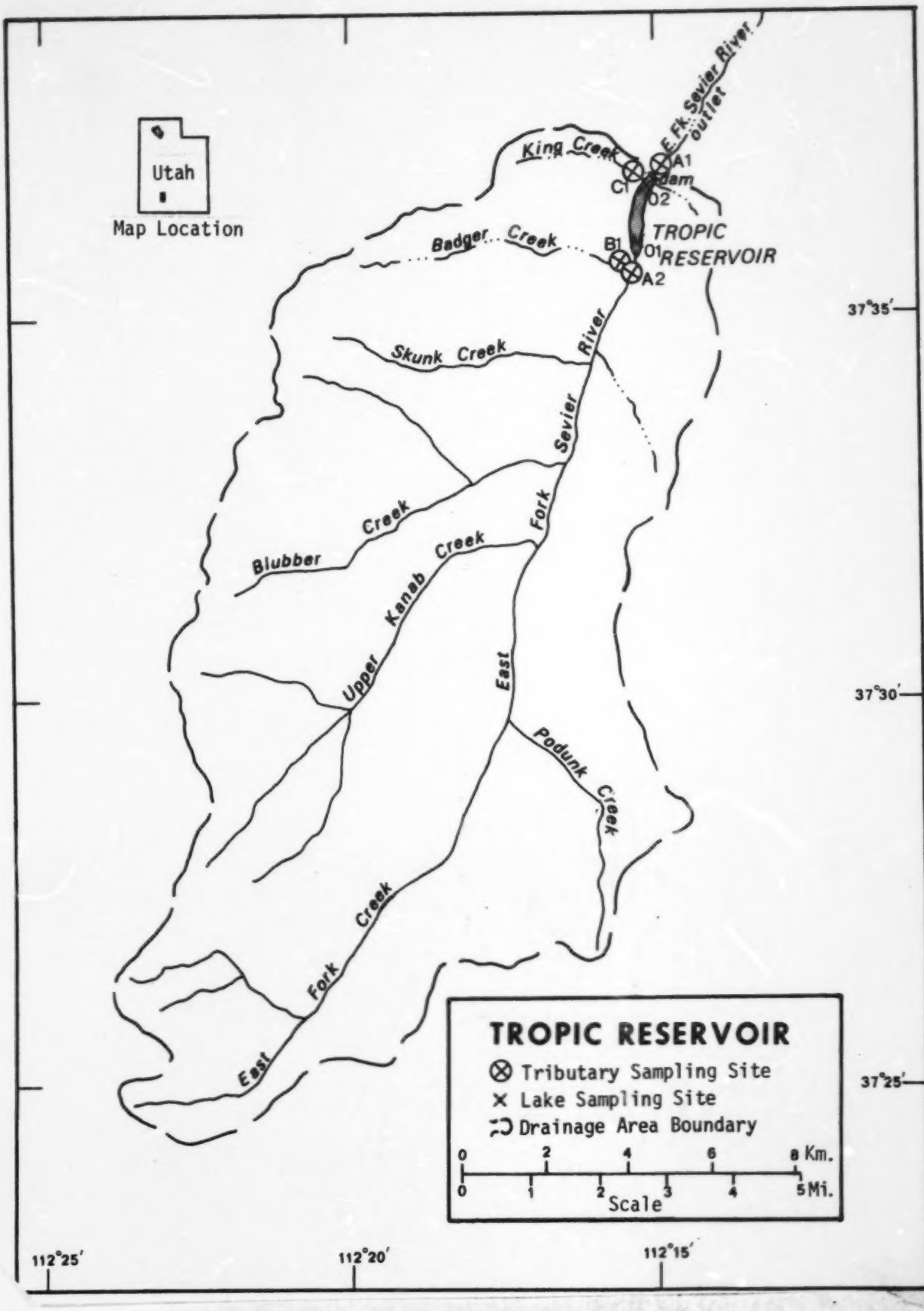
Major General Maurice L. Watts, the Adjutant General of Utah, and Project Officer Lt. Colonel T. Ray Kingston, who directed the volunteer efforts of the Utah National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF UTAH

NAME	COUNTY
Bear	Rich, UT; Bear Lake, ID
Deer Creek	Wasatch
Echo	Summit
Fish	Sevier
Flaming Gorge	Daggett, UT; Sweetwater, WY
Huntington	Emery
Joes Valley	Emery
Lower Bowns	Garfield
Lynn	Box Elder
Minersville	Beaver
Moon	Duchesne
Navajo	Kane
Newcastle	Iron
Otter Creek	Piute
Panguich	Garfield
Pelican	Uintah
Pineview	Weber
Piute	Piute
Porcupine	Cache
Powell	Garfield, Kane, San Juan, UT; Coconino, AZ
Pruess	Millard
Sevier Bridge	Juab, Sanpete
Starvation	Duchesne
Steinaker	Uintah
Tropic	Garfield
Utah	Utah
Willard Bay	Box Elder


Utah
Map Location
King Creek
E. Fk. Sevier River outlet
A1
C1
dam
O2
TROPIC RESERVOIR
Badger Creek
B1
O1
A2
37°35'
Skunk Creek
River
Sevier
Fork
Blubber Creek
Upper Kanab Creek
East
37°30'
Podunk Creek
East Fork Creek
TROPIC RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0 2 4 6 8 Km.
0 1 2 3 4 5 Mi.
Scale
37°25'
112°25'
112°20'
112°15'

TROPIC RESERVOIR

STORET NO. 4923

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Tropic Reservoir is mesoeutrophic. It ranked eleventh in overall trophic quality when the 27 Utah lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Nine of the water bodies had less median total phosphorus, ten had less and three had the same median dissolved orthophosphorus, 12 had less and one had the same median inorganic nitrogen, 14 had less mean chlorophyll a, and 12 had greater mean Secchi disc transparency.

Survey limnologists observed an algal bloom in August and noted that aquatic macrophytes occupied much of the reservoir bottom in August and September.

B. Rate-Limiting Nutrient:

The results of the algal assay indicate phosphorus limitation in May. The reservoir data indicate phosphorus limitation in May and nitrogen limitation in August and September.

C. Nutrient Controllability:

1. Point sources--No known wastewater treatment plants impacted Tropic Reservoir during the sampling year.

The present phosphorus loading of 0.40 $g/m^2/yr$ is less than that proposed by Vollenweider (Vollenweider and Dillon,

* See Appendix A.

1974) as an oligotrophic loading (see page 11). However, the hydraulic retention time of the reservoir is a rather short 56 days, and Vollenweider's model may not apply. Note that less than 12% of the phosphorus load was retained and an apparent loss of nitrogen occurred during the sampling year.

2. Non-point sources--Non-point sources, including direct precipitation, contributed all of the total phosphorus load to the reservoir. The East Fork of the Sevier River added 89.8% of the total; Badger Creek, 1.7%; and the ungaged tributaries contributed an estimated 3.4%.

The phosphorus export rates of the East Fork Sevier River and Badger Creek were very low during the sampling year (1 and < 1 kg/km^2 respectively; see page 10).

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 0.73 kilometers^2.
2. Mean depth: 3.0 meters.
3. Maximum depth: 9.1 meters.
4. Volume: 2.159×10^6 m^3.
5. Mean hydraulic retention time: 56 days (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
E. Fk. Sevier River	191.7	0.440
Badger Creek	14.0	0.007
King Creek	5.4	0.005
Minor tributaries & immediate drainage -	5.8	0.011
Totals	216.9	0.463

2. Outlet -

E. Fk. Sevier River	217.6**	0.445

C. Precipitation***:

1. Year of sampling: 20.8 centimeters.
2. Mean annual: 28.5 centimeters.

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† Table of metric equivalents--Appendix B.
†† Sudweeks, 1975.
* For limits of accuracy, see Working Paper No. 175, "... Survey Methods, 1973-1976".
** Includes area of reservoir.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Tropic Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at one station in May and August and from two stations in September (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was collected (composited in September) from the station(s) for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was collected for algal assays. Also each time, a depth-integrated sample was collected from the station(s) for chlorophyll *a* analysis. The maximum depths sampled were near-surface only at station 1 and 5.8 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR TROPIC RESERVOIR
STORET CODE 4923

PARAMETER	1ST SAMPLING (5/ 8/75) 1 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/25/75) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (8/14/75) 1 SITES RANGE	MEAN	MEDIAN
TEMP (C)	4.3 - 4.3	4.3	4.3	13.5 - 15.3	14.6	15.1	15.8 - 16.0	15.9	15.9
DISS OXY (MG/L)	9.0 - 9.0	9.0	9.0	9.2 - 10.4	9.7	9.4	6.6 - 6.6	6.6	6.6
CNDCTVY (MCROMO)	247. - 247.	247.	247.	218. - 245.	228.	221.	116. - 117.	116.	116.
PH (STAND UNITS)	8.4 - 8.4	8.4	8.4	8.8 - 9.0	8.9	8.8	8.7 - 8.9	8.8	8.8
TOT ALK (MG/L)	242. - 242.	242.	242.	170. - 193.	179.	174.	73. - 75.	74.	74.
TOT P (MG/L)	0.026 - 0.026	0.026	0.026	0.012 - 0.015	0.013	0.013	0.021 - 0.022	0.021	0.021
ORTHO P (MG/L)	0.006 - 0.006	0.006	0.006	0.002 - 0.006	0.003	0.002	0.011 - 0.012	0.011	0.011
NO2+NO3 (MG/L)	0.080 - 0.080	0.080	0.080	0.020 - 0.020	0.020	0.020	0.020 - 0.030	0.023	0.020
AMMONIA (MG/L)	0.030 - 0.030	0.030	0.030	0.020 - 0.020	0.020	0.020	0.020 - 0.040	0.030	0.030
KJEL N (MG/L)	0.600 - 0.600	0.600	0.600	0.200 - 0.400	0.300	0.300	0.400 - 0.400	0.400	0.400
INORG N (MG/L)	0.110 - 0.110	0.110	0.110	0.040 - 0.040	0.040	0.040	0.050 - 0.060	0.053	0.050
TOTAL N (MG/L)	0.680 - 0.680	0.680	0.680	0.220 - 0.420	0.320	0.320	0.420 - 0.430	0.423	0.420
CHLRPYL A (UG/L)	17.0 - 17.0	17.0	17.0	1.0 - 1.4	1.2	1.2	9.4 - 9.4	9.4	9.4
SECCHI (METERS)	0.3 - 0.3	0.3	0.3	1.2 - 3.0	2.1	2.1	3.0 - 3.0	3.0	3.0

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/08/75	1. Oscillatoria sp.	14
	Total	14
08/14/75	1. Gloeotrichia sp.	4,660
	2. Chroomonas sp.	98
	3. Anabaena sp.	65
	4. Staurastrum sp.	33
	Total	4,856
09/25/75	1. Chroomonas sp.	80
	2. Cryptomonas sp.	40
	3. Pediastrum sp.	20
	Total	140

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
05/08/75	1	17.0
	2	-
08/14/75	1	-
	2	9.4
09/25/75	1	1.0
	2	1.4

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	< 0.005	0.095	0.2
0.050 P	< 0.055	0.095	2.7
0.050 P + 1.0 N	< 0.055	1.095	25.0
1.0 N	< 0.005	1.095	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Tropic Reservoir was moderately low at the time the sample was taken (05/08/75). Also, the significant increase in yield when only phosphorus was added, and the lack of response with the addition of nitrogen alone, indicate the reservoir was phosphorus limited at that time.

The reservoir data indicate phosphorus limitation in May and nitrogen limitation in August and September. The mean inorganic nitrogen to orthophosphorus ratios were 18 to 1 in May, 5 to 1 in August, and 13 to 1 in September.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Utah National Guard collected monthly near-surface grab samples when possible from each of the tributary sites indicated on the map (page v). Sampling was begun in November, 1974, and was completed in October, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Utah District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

Except for King Creek, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Although King Creek was sampled 11 times, flows were too low to be measured accurately, and nutrient loads for this stream and for the unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations A-2 and B-1 and multiplying the means by the King Creek and ZZ areas in km^2.

No wastewater treatment plants impacted Tropic Reservoir during the sampling year.

---

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
E. Fk. Sevier River	265	89.8
Badger Creek	5	1.7
King Creek	5	1.7
b. Minor tributaries & immediate drainage (non-point load) -	5	1.7
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	15	5.1
Total	295	100.0

2. Outputs -

Lake outlet - E. Fk. Sevier River 260

3. Net annual P accumulation - 35 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
E. Fk. Sevier River	7,700	86.1
Badger Creek	160	1.8
King Creek	140	1.6
b. Minor tributaries & immediate drainage (non-point load) -	150	1.7
c. Known municipal STP's - None	-	-
d. Septic tanks - Unknown	?	-
e. Known industrial - None	-	-
f. Direct precipitation* -	790	8.8
Total	8,940	100.0

2. Outputs -

Lake outlet - E Fk. Sevier River 10,810

3. Net annual N loss - 1,870 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
E. Fk. Sevier River	1	40
Badger Creek	< 1	11

E. Mean Nutrient Concentrations in King Creek:

Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
0.014	0.923

* See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.40	0.05	12.2	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Tropic Reservoir:

"Dangerous" (eutrophic loading)	0.84
"Permissible" (oligotrophic loading)	0.42

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the reservoir, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, unsampled point sources discharging directly to the reservoir, or (probably) insufficient outlet sampling in relation to the relatively short hydraulic retention time. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

Malueg, Kenneth W., D. Phillips Larsen, Donald W. Schults, and Howard T. Mercier; 1975. A six-year water, phosphorus, and nitrogen budget for Shagawa Lake, Minnesota. Jour. Environ. Qual., vol. 4, no. 2, pp. 236-242.

Sudweeks, Calvin K., 1975. Personal communication (reservoir morphometry). UT Bur. of Env. Health. Salt Lake City.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	1$-MIN DO	MEDIAN DISS ORTHO P
0408	LAKE POWELL	0.010	0.410	339.830	3.081	13.800	0.007
4901	BEAR LAKE	0.011	0.040	253.167	0.945	9.200	0.003
4902	LOWER BOWN'S RESERVOIR	0.031	0.040	336.000	5.567	9.400	0.006
4903	DEER CREEK RESERVOIR	0.038	0.215	430.333	9.078	14.800	0.006
4904	ECHO RESERVOIR	0.047	0.170	450.333	6.967	14.000	0.012
4905	LYNN RESERVOIR	0.121	0.200	417.667	39.600	10.400	0.052
4906	FISH LAKE	0.023	0.040	152.000	12.483	10.400	0.004
4907	HUNTINGTON NORTH RESERVO	0.013	0.040	392.000	1.900	7.800	0.005
4908	JOE'S VALLEY RESERVOIR	0.012	0.045	400.000	2.483	11.200	0.003
4909	MINERSVILLE RESERVOIR	0.192	0.860	445.000	33.583	8.600	0.107
4910	MOON LAKE	0.008	0.040	381.000	2.700	9.600	0.002
4911	NAVAJO LAKE	0.016	0.040	368.000	2.000	6.000	0.003
4912	NEWCASTLE RESERVOIR	0.051	0.040	428.667	12.467	13.600	0.009
4913	OTTER CREEK RESERVOIR	0.067	0.040	453.667	11.767	10.600	0.033
4914	PANGUITCH LAKE	0.071	0.040	426.500	45.950	14.200	0.010
4915	PELICAN LAKE	0.044	0.050	438.000	6.350	8.400	0.004
4916	PINEVIEW RESERVOIR	0.028	0.308	435.083	5.692	14.600	0.006
4917	PIUTE RESERVOIR	0.047	0.150	482.625	25.329	11.600	0.007
4918	PORCUPINE RESERVOIR	0.025	0.110	440.000	7.860	12.400	0.011
4919	PRUESS RESERVOIR (GARRIS	0.057	0.140	491.000	4.533	8.800	0.008
4920	SEVIER BRIDGE RESERVOIR	0.026	0.355	449.778	18.222	12.400	0.008
4921	STARVATION RESERVOIR	0.016	0.040	394.583	5.675	13.200	0.004
4922	STEINAKER RESERVOIR	0.011	0.040	316.750	1.844	12.600	0.005
4923	TROPIC RESERVOIR	0.021	0.050	425.000	7.200	8.400	0.006
4924	UTAH LAKE	0.132	0.320	490.583	72.012	11.400	0.012
4925	WILLARD BAY RESERVOIR	0.044	0.060	457.182	7.567	11.000	0.009
5605	FLAMING GORGE RESERVOIR	0.011	0.690	285.636	2.500	10.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
0408	LAKE POWELL	96 (25)	4 (1)	81 (21)	73 (19)	15 (4)	42 (11)	311
4901	BEAR LAKE	90 (23)	87 (19)	96 (25)	100 (26)	77 (20)	90 (23)	540
4902	LOWER BOWN'S RESERVOIR	46 (12)	87 (19)	85 (22)	65 (17)	73 (19)	50 (13)	406
4903	DEER CREEK RESERVOIR	42 (11)	19 (5)	42 (11)	35 (9)	0 (0)	58 (14)	196
4904	ECHO RESERVOIR	31 (8)	27 (7)	19 (5)	50 (13)	12 (3)	13 (3)	152
4905	LYNN RESERVOIR	8 (2)	23 (6)	58 (15)	8 (2)	62 (15)	4 (1)	163
4906	FISH LAKE	62 (16)	65 (16)	100 (26)	23 (6)	62 (15)	79 (20)	391
4907	HUNTINGTON NORTH RESERVO	77 (20)	65 (16)	69 (18)	92 (24)	96 (25)	69 (18)	468
4908	JOE'S VALLEY RESERVOIR	81 (21)	58 (15)	62 (16)	85 (22)	46 (12)	96 (25)	428
4909	MINERSVILLE RESERVOIR	0 (0)	44 (11)	27 (7)	12 (3)	85 (22)	0 (0)	168
4910	MOON LAKE	100 (26)	87 (19)	73 (19)	77 (20)	69 (18)	100 (26)	506
4911	NAVAJO LAKE	69 (18)	87 (19)	77 (20)	88 (23)	100 (26)	85 (22)	506
4912	NEWCASTLE RESERVOIR	23 (6)	87 (19)	46 (12)	27 (7)	19 (5)	27 (7)	229
4913	OTTER CREEK RESERVOIR	15 (4)	87 (19)	15 (4)	31 (8)	54 (14)	8 (2)	210
4914	PANGUITCH LAKE	12 (3)	65 (16)	50 (13)	4 (1)	8 (2)	23 (6)	162
4915	PELICAN LAKE	37 (9)	54 (14)	35 (9)	54 (14)	90 (23)	73 (19)	343
4916	PINEVIEW RESERVOIR	50 (13)	15 (4)	38 (10)	58 (15)	4 (1)	58 (14)	223
4917	PIUTE RESERVOIR	27 (7)	31 (8)	8 (2)	15 (4)	38 (10)	46 (12)	165
4918	PORCUPINE RESERVOIR	58 (15)	38 (10)	31 (8)	38 (10)	33 (8)	19 (5)	217
4919	PRUESS RESERVOIR (GARRIS	19 (5)	35 (9)	8 (8)	69 (18)	81 (21)	37 (9)	241
4920	SEVIER BRIDGE RESERVOIR	54 (14)	8 (2)	23 (6)	19 (5)	33 (8)	37 (9)	174
4921	STARVATION RESERVOIR	73 (19)	87 (19)	65 (17)	62 (16)	23 (6)	79 (20)	389
4922	STEINAKER RESERVOIR	85 (22)	87 (19)	88 (23)	96 (25)	27 (7)	65 (17)	448
4923	TROPIC RESERVOIR	65 (17)	50 (13)	54 (14)	46 (12)	90 (23)	58 (14)	363
4924	UTAH LAKE	4 (1)	12 (3)	4 (1)	0 (0)	42 (11)	13 (3)	75
4925	WILLARD BAY RESERVOIR	37 (9)	44 (11)	12 (3)	42 (11)	50 (13)	31 (8)	216
5605	FLAMING GORGE RESERVOIR	90 (23)	8 (0)	92 (24)	81 (21)	62 (15)	90 (23)	415

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4901	BEAR LAKE	540
2	4911	NAVAJO LAKE	506
3	4910	MOON LAKE	506
4	4907	HUNTINGTON NORTH RESERVO	468
5	4922	STEINAKER RESERVOIR	448
6	4908	JOE'S VALLEY RESERVOIR	428
7	5605	FLAMING GORGE RESERVOIR	415
8	4902	LOWER BOWN'S RESERVOIR	406
9	4906	FISH LAKE	391
10	4921	STARVATION RESERVOIR	389
11	4923	TROPIC RESERVOIR	363
12	4915	PELICAN LAKE	343
13	0408	LAKE POWELL	311
14	4919	PRUESS RESERVOIR (GARRIS	241
15	4912	NEWCASTLE RESERVOIR	229
16	4916	PINEVIEW RESERVOIR	223
17	4918	PORCUPINE RESERVOIR	217
18	4925	WILLARD BAY RESERVOIR	216
19	4913	OTTER CREEK RESERVOIR	210
20	4903	DEER CREEK RESERVOIR	196
21	4920	SEVIER BRIDGE RESERVOIR	174
22	4909	MINERSVILLE RESERVOIR	168
23	4917	PIUTE RESERVOIR	165
24	4905	LYNN RESERVOIR	163
25	4914	PANQUITCH LAKE	162
26	4904	ECHO RESERVOIR	152
27	4924	UTAH LAKE	75

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR UTAH 10/18/76

LAKE CODE 4923 TROPIC RES

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 217.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4923A1	217.6	0.028	0.113	0.227	0.538	1.699	1.359	0.510	0.311	0.227	0.255	0.028	0.028	0.445
4923A2	191.7	0.23	0.28	0.37	0.88	1.42	0.54	0.25	0.25	0.23	0.25	0.28	0.28	0.44
492381	14.0	0.003	0.006	0.006	0.014	0.023	0.008	0.003	0.003	0.003	0.006	0.006	0.006	0.007
4923C1	5.4	0.003	0.003	0.006	0.011	0.017	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.005
4923ZZ	6.2	0.006	0.008	0.008	0.023	0.037	0.014	0.006	0.006	0.006	0.006	0.008	0.008	0.011

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 217.6
SUM OF SUB-DRAINAGE AREAS = 217.3

TOTAL FLOW IN = 5.55
TOTAL FLOW OUT = 5.32

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4923A1	11	74	0.142	9	0.142				
	12	74	0.142	15	0.057				
	1	75	0.142	11	0.113				
	2	75	0.765	9	0.142				
	3	75	0.142	8	0.028				
	4	75	0.340						
	5	75	0.680	3	0.651				
	6	75	0.623	24	0.566				
	7	75	0.510	12	0.481				
	8	75	0.651	9	0.623				
	9	75	0.425	7	0.425				
	10	75	0.142	11	0.142				
4923A2	11	74	0.283	9	0.311				
	12	74	0.283	14	0.283				
	1	75	0.311	11	0.269				
	2	75	0.311	9	0.340				
	3	75	0.680	8	0.453				
	4	75	1.529	7	1.954				
	5	75	1.444	3	1.671				
	6	75	0.651	24	0.425				
	7	75	0.283	12	0.538				
	8	75	0.198	9	0.150				
	9	75	0.227	7	0.164				
	10	75	0.198	11	0.193				

TRIBUTARY FLOW INFORMATION FOR UTAH 10/18/76

LAKE CODE 4923 TROPIC RES

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
492381	11	74	0.006	9	0.006				
	12	74	0.006	14	0.006				
	1	75	0.006	11	0.006				
	2	75	0.006	9	0.006				
	3	75	0.011	8	0.008				
	4	75	0.025						
	5	75	0.025	3	0.028				
	6	75	0.011	24	0.006				
	7	75	0.006	12	0.006				
	8	75	0.003	9	0.003				
	9	75	0.003	7	0.003				
	10	75	0.003	11	0.003				
4923C1	11	74	0.003						
	12	74	0.003						
	1	75	0.003						
	2	75	0.006						
	3	75	0.008						
	4	75	0.020						
	5	75	0.020						
	6	75	0.008						
	7	75	0.003						
	8	75	0.003						
	9	75	0.003						
	10	75	0.003						
4923ZZ	11	74	0.008						
	12	74	0.008						
	1	75	0.008						
	2	75	0.008						
	3	75	0.017						
	4	75	0.040						
	5	75	0.040						
	6	75	0.017						
	7	75	0.008						
	8	75	0.006						
	9	75	0.006						
	10	75	0.006						

APPENDIX D

PHYSICAL and CHEMICAL DATA

...ET RETRIEVAL DATE 76/08/12

492301
37 35 53.0 112 15 11.0 3
TROPIC RESERVOIR
49017 UTAH

150892

11EPALES 2111202
0003 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/08	14 50	0000	4.3	9.0	12	247	8.40	242	0.030	0.600	0.080	0.006
75/09/25	14 10	0000	13.5	10.4	48L	245	8.85	193	0.020K	0.300	0.020K	0.002K

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/08	14 50	0000	0.026	17.0	
75/09/25	14 10	0000	0.013	1.0	

K VALUE KNOWN TO BE
LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE
GREATER THAN VALUE GIVEN

23

STORET RETRIEVAL DATE 76/08/12

492302
37 36 42.0 112 15 01.0 3
TROPIC RESERVOIR
49017 UTAH

11EPALES 2111202
0023 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/14	07 55	0000	16.0	6.6	120	116	8.70	73	0.020K	0.400	0.030	0.011
	07 55	0005	15.9			117	8.90	74	0.030	0.400	0.020K	0.011
	07 55	0019	15.8			116	8.80	75	0.040	0.400	0.020K	0.012
75/09/25	14 30	0000	15.3	9.2	120L	218	8.85	170	0.020K	0.200	0.020K	0.002
	14 30	0006	15.1	9.4		221	9.05	174	0.020K	0.400	0.020K	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/14	07 55	0000	0.022	9.4	
	07 55	0005	0.021		
	07 55	0019	0.021		
75/09/25	14 30	0000	0.012	1.4	
	14 30	0006	0.015		

K VALUE KNOWN TO BE
LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE
GREATER THAN VALUE GIVEN

APPENDIX E

TRIBUTARY DATA

ET RETRIEVAL DATE 76/08/12

4923A1
37 36 46.0 112 14 54.0 4
E FORK SEVIER RIVER
49 7.5 BRYCE POINT
0/TROPIC RESERVOIR 110292
BELO TROPIC RES DAM NEAR SPLWY FRM GR RD
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	16	10	0.027	0.900	0.025	0.005	0.010K
74/12/15	10	00	0.008	0.700	0.065	0.005K	0.020
75/01/11	10	55	0.008K	0.500	0.010	0.005K	0.010
75/02/09	11	00	0.024	0.200	0.024	0.008K	0.030
75/03/08	11	20	0.049	0.800	0.016	0.008K	0.020
75/05/03	10	05	0.057	0.450	0.191	0.020	0.020
75/06/24	13	00	0.005	0.250	0.020	0.005K	0.010K
75/07/12	12	00	0.005	3.150	0.015	0.005K	0.050K
75/08/09	12	10	0.005	0.500	0.015	0.005K	0.010K
75/09/07	09	50	0.005	0.200	0.010	0.010	0.030
75/10/11	11	30	0.015	0.700	0.015	0.005	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

4923A2
37 35 30.0 112 15 19.0 4
E FORK SEVIER RIVER
49 7.5 TROPIC RES
T/TROPIC RESERVOIR 150892
DRT RD .3 MI W OF JCT WITH GRAVEL RD
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	16	40	0.016	0.600	0.025	0.005	0.010K
75/05/03	10	25	0.100	0.750	0.100	0.010	0.010
75/06/24	13	30	0.005	0.200	0.015	0.005K	0.010K
75/07/12	12	15	0.055	0.600	0.005	0.005K	0.090
75/08/09	12	35	0.005	0.200	0.010	0.005K	0.010
75/09/07	10	20	0.005	0.100	0.005	0.005	0.020
75/10/11	12	00	0.005	0.100K	0.005K	0.005K	0.010K

K VALUE KNOWN TO BE
LESS THAN INDICATED

26a

STORET RETRIEVAL DATE 76/08/12

492381
37 35 35.0 112 15 20.0 4
BADGER CREEK
49 7.5 TROPIC RES
T/TROPIC RESERVOIR 150892
DRT RD .4 MI WNW OF JCT WITH GRAVEL RD
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	16	50	0.184	0.500	0.025	0.010	0.010
75/05/03	10	30	0.155	1.250	0.054	0.020	0.020
75/06/24	13	25	0.005	0.337	0.020	0.005K	0.020
75/07/12	12	10	0.055	0.200	0.005	0.005K	0.010
75/08/09	12	30	0.050	0.325	0.010	0.005K	0.010K
75/09/07	10	15	0.050	0.600	0.005	0.005K	0.030
75/10/11	11	50	0.150	0.100	0.005K	0.005K	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

4923C1
37 36 40.0 112 15 17.0 4
KING CREEK
49 7.5 TROPIC RES
T/TROPIC RESERVOIR 150892
GRVL RD BRDG .3 MI WSW OF TROPIC RES DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/09	16	25	0.200	0.600	0.040	0.010	0.010
74/12/14	10	25	0.200	1.800	0.025	0.005	0.010K
75/01/11	11	10	0.192	0.300	0.005K	0.005K	0.010
75/02/09	11	10	0.184	0.500	0.016	0.008K	0.020
75/03/08	12	00	0.180	2.100	0.020	0.008K	0.010K
75/05/03	10	15	0.210	1.600	0.035		
75/06/24	13	10	0.150	0.250	0.015	0.005K	0.020
75/07/12	12	05	0.170	0.100	0.005K	0.005	0.010K
75/08/09	12	15	0.170	0.150	0.010	0.005K	0.010K
75/09/07	10	00	0.180	0.400	0.025	0.010	0.030
75/10/11	11	40	0.220	0.300	0.005K	0.005K	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED